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Commonwealth of Pennsylvania
Environmental Resources
December 11, 1987

Subject: Source Test Review

To: Data File
Bethlehem Steel Corporation
Bethlehem, Northampton County

From: John S. Pitulski *J.S.P.*
Air Quality Program Specialist
Division of Technical Services and Monitoring
Bureau of Air Quality Control

Through: Chief, Source Testing and Monitoring Section *107*

Coke Oven Battery "A" at Bethlehem Steel Corporation is an 80-oven battery of 6 meter high ovens having double gas collector mains. Coke is pushed from the oven into a conventional moving quench car. The emissions generated during the pushing operation are captured by a hood mounted on the door machine. The hood is connected to a land based duct system which conveys the captured gases and particulate to a venturi scrubber and cyclonic separator located at the west end of the battery. The gases from the separator are then exhausted through an induced draft fan to the stack.

On August 27, 1987 particulate emission testing was conducted by BCM, Inc. at the battery exhaust stack. The test was conducted in accordance with pre-approved procedures and is acceptable to the Department. The nature of the source prohibits the sample volume and sampling time from meeting the requirements of Chapter 139 of the Department of Environmental Resources' Rules and Regulations. The calculations are correct and the results appear to be valid.

The following information was extracted from the test report:

Number of Ovens Pushed During Test	16
Coke Pushed During Test (dry tons/oven)	23.45
Volumetric Flowrate (dscfm)	152447
Emission Rate (lb/hr)	4.69
Allowable Emission Rate (lb/hr)	4.74
Percent Isokinetic	107

BETHLEHEM STEEL CORPORATION
BETHLEHEM PLANT

"A" Battery Pushing Emission Control System
Particulate Emissions Evaluation

~~Pursuant to the requirement of DER Regulations Chapter 139, parti-~~
culate emission tests were conducted on the "A" Coke Oven Battery pushing
emission control system stack on August 27, 1987. Testing and analyses
were performed in a manner similar to the procedure outlined for the
evaluation of the one spot car at our Plant's No. 5 Coke Oven Battery. Use
of this procedure has been approved by Mr. R. St. Louis of the Department's
Testing branch.

Source Description

"A" Battery is an 80 oven battery of 6 meter high ovens having double
gas collector mains. Coke is pushed from the ovens into a conventional
moving quench car. The emissions generated during the pushing operation
are captured by a hood mounted on the door machine. This hood is connected
to a land based duct system which conveys the captured gases and parti-
culate to a venturi scrubber and cyclonic separator system at the west end
of the battery. The gases from the system are then exhausted through the
induced draft fans to the stack.

During these tests the average net coking time was 24.0 hours. The
ovens pushed during the testing periods are identified on Attachment 1.
The average tonnage of coke pushed on the battery during the test was 23.45
tons per oven.

Venturi pressure drops during the test were 36 and 33 inches of water
on the north and south scrubber respectively. During the test, water flow
rates averaged 590 and 610 GPM to the north and south venturis.

Test Procedure

All equipment and analytical procedures conformed to EPA Method 5.
Sixteen pushes were sampled during the tests. Sampling commenced at the
movement of the coke mass and terminated 30 seconds after the completion of
the push. Each push was sampled at a different point, with 8 points on
each diameter. Location of the test ports is identified on Attachment 2.

Sampling Results

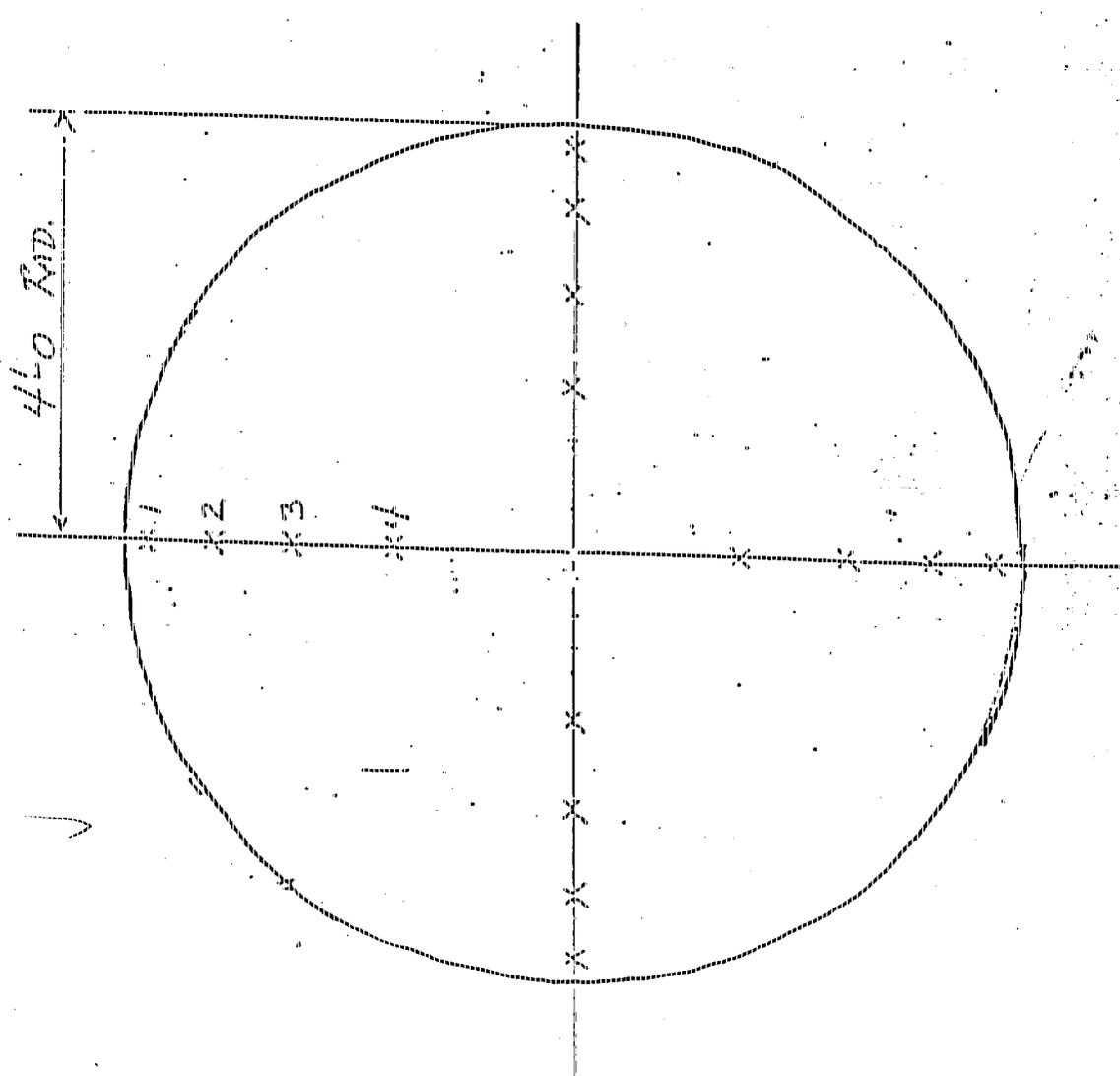
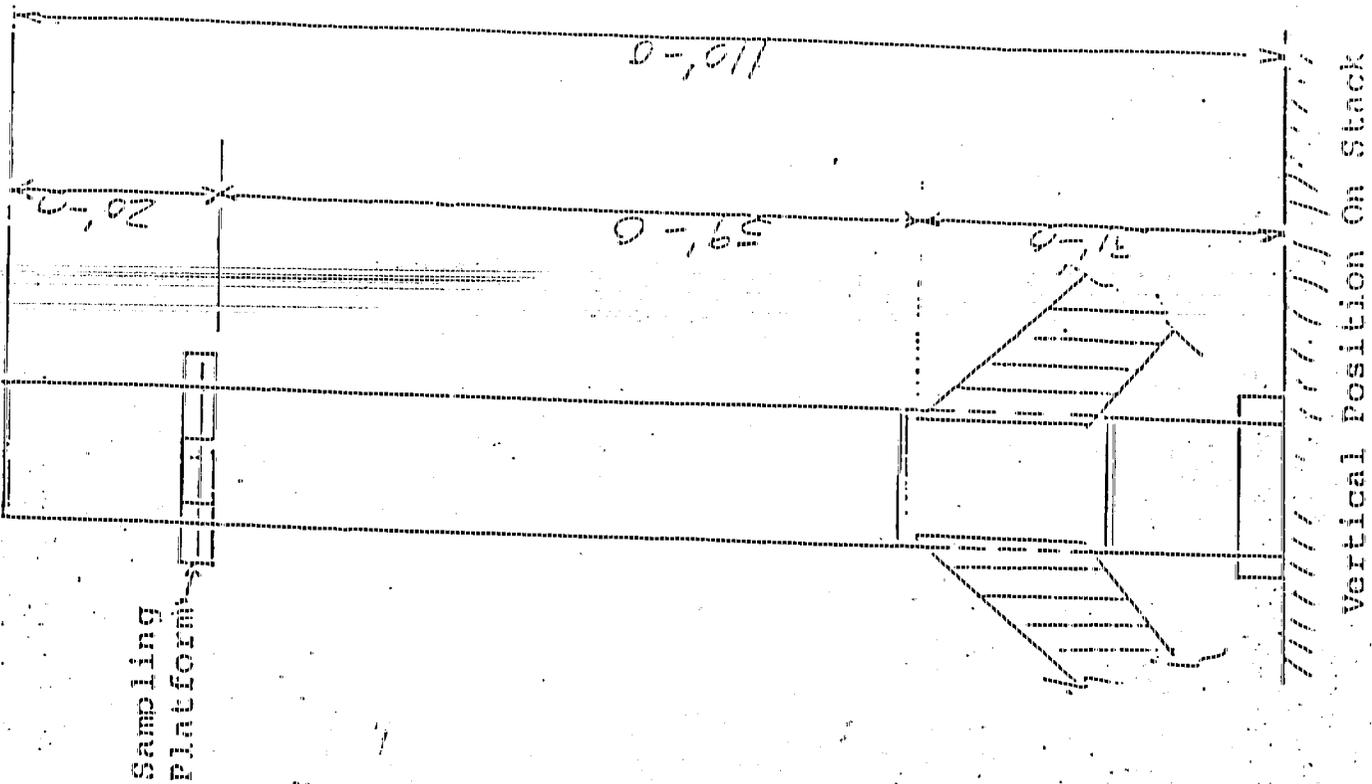
Test results are summarized in BCM's test report, Attachment 3. The total
particulate loading (front half plus back half insolubles) for the test was
calculated as 4.65 lb./hr. The calculated allowable limit is 4.74 lb./hr.
The calculations for the allowable and actual emission loading are
presented on Attachment 4.

Attachment 1

"A" Battery Scrubber Test 08/27/87
Ovens Pushed

<u>Oven No.</u>	<u>Time</u>
8	11:34
18	11:46
38	12:09
48	12:18
58	12:35
68	12:49
78	15:15
88	15:23
11	15:47
21	16:04
51	17:12
61	17:23
71	17:38
81	17:50
3	18:01
13	18:36

After Stack Stuffer Replaced Fan Outlet Silencers
March 1986.



HORIZONTAL CROSS SECTION

VERTICAL POSITION ON STACK

Attachment 4

"A" Battery Scrubber Test 08/27/87
Loading Calculations

Average coke time = 24.0 hours

No. of oven pushed per day = 80 ovens/day

Average tons of coke per oven = 23.45 dry tons/oven

Average number of pushes per hour = 3.33 oven/hr.

Number of pushes for test = 16 pushes

Total amount of test time = 23' 15" (23.25 min.)

Total amount of push time per hour = 4.83 min./hr.

Allowable Loading

$$W = (23.45 \text{ tons of coke/oven}) \times (3.33 \text{ Oven/hr.}) = 78.09 \text{ tons/hr.}$$

$$E = (78.09 \text{ tons/hr.}) \times (1 \text{ lb. emissions/ton coke}) = 78.09 \text{ lb./hr.}$$

$$A = 0.76(E)^{0.42} = 0.76(78.09 \text{ lb./hr.})^{0.42} = \underline{4.74 \text{ lb./hr.}}$$

Actual Loading

$$\text{Loading (lb./hr.)} = \frac{(\text{gr/scfd}) (\text{Qstpd}) (\text{min./hr.})}{7000}$$

$$\text{Loading (lb./hr.)} = \frac{(0.0445 \text{ gr/scfd}) (151284 \text{ scfmd}) (4.83 \text{ min./hr.})}{7000}$$

$$\text{Loading (lb./hr.)} = \underline{4.65 \text{ lb./hr.}}$$

EMISSION EVALUATION

OF THE

"A" BATTERY PUSH EMISSION SCRUBBER

FOR

BETHLEHEM STEEL CORPORATION
BETHLEHEM, PENNSYLVANIA

NOVEMBER 1987

BCM PROJECT NO. 00-4021-12

PREPARED BY


DAVID S. LIVINGSTONE
SCIENTIST

AND


ASHOK K. SANYAL, P.E.
ASSISTANT VICE PRESIDENT



1.0 EXECUTIVE SUMMARY

Bethlehem Steel Corporation (Bethlehem Steel) retained BCM Eastern Inc. (BCM) to conduct an emission evaluation of the "A" Battery Push Emission Scrubber at its Bethlehem Plant. Testing was conducted on the outlet stack to determine compliance with Pennsylvania Department of Environmental Resources (PADER) air pollution regulations. On August 27, 1987, BCM conducted a particulate test that consisted of collecting emissions from 16 coke oven pushes.

The results of the test indicate that the "A" Battery Push Emission Scrubber exhaust stack emission rate was 57.76 lb/hr.



2.0 SCOPE AND OBJECTIVES

The scope of the project was discussed by Mr. Bruce Sandmaier of Bethlehem Steel, and Mr. James Antonik of BCM. The objective of the sampling program was to determine the following parameters:

- Gas flow - acfm and scfm
- Gas temperature - °F
- Moisture - percent by volume
- Particulate loading - gr/dscf and lb/hr
- Combustion gas analysis - percent by volume CO₂, O₂, and N₂ (by difference)



3.0 PROCEDURES

3.1 FIELDWORK

Field testing was conducted on August 27, 1987. The sampling team consisted of the following personnel:

Thomas Bernstiel - Scientist
William Kesack - Engineer
David Livingstone - Scientist

Mr. Bruce Sandmaier acted as liaison between BCM and Bethlehem Steel, and ensured that the process operated normally during the test period.

The following methods of sampling were employed in the test program:

1. Sampling and traverse locations were determined in accordance with Method 1 of the Federal Register, Volume 42, Number 160, August 18, 1977 (see Appendix 1).
2. Gas flow, gas temperature, and static pressure measurements were made in accordance with Method 2 of the Federal Register, Volume 42, Number 160, August 18, 1977 (see Appendix 1).
3. Particulate sampling was conducted in accordance with PADER Methodology, and Method 5 of the Federal Register, Volume 42, Number 160, August 18, 1977 (see Appendix 1).
4. A Fyrite gas analyzer was used to determine the molecular weight of the flue gas. The following parameters were measured to calculate the molecular weight of the dry flue gas: volume percent carbon dioxide, and volume percent oxygen. The volume percent nitrogen was determined by difference. The specific procedure is outlined in Appendix 1.
5. Moisture content sampling was conducted in accordance with Method 4 of the Federal Register, Volume 42, Number 160, August 18, 1977. The methodology is outlined in Appendix 1.



3.2 EQUIPMENT CALIBRATION

In accordance with the procedures established by the U.S. Environmental Protection Agency (EPA), all gas velocity measuring equipment, volume metering equipment, temperature measuring equipment, and flow rate metering equipment had been calibrated within 60 days of the test date. Calibration data are included in Appendix 3.

3.3 ANALYTICAL METHODS

All samples generated during the sampling program were returned to the BCM Laboratory in Norristown, Pennsylvania, for analyses. Laboratory data are reported in Appendix 2.

3.4 CALCULATIONS

All particulate concentrations, moisture content, gas flow, and molecular weight calculations were prepared by computer. Raw data generated during the field sampling program and the results of the laboratory analyses were introduced into equations presented in Methods 2, 3, 4, and 5 of the Federal Register, Volume 42, Number 160, August 18, 1977. Computer input and all other data appear in Appendix 2.



4.0 SUMMARY OF RESULTS

The parameters evaluated by the PADER method are contained in Appendix 2. Pertinent test results are listed below.

<u>Run Number</u>	<u>Emission Concentration (gr/dscf)</u>	<u>Emission Rate (lb/hr)</u>
1	0.0445	57.76



5.0 DISCUSSION OF RESULTS

5.1 GENERAL

The testing program was comprised of one particulate test on the "A" Battery Push Emission Scrubber exhaust stack.

5.2 PARTICULATE TESTING

The particulate emission concentration was 0.0445 grain/dry standard cubic foot (gr/dscf), and the emission rate was 57.76 pounds/hour (lb/hr). These data will be used by Bethlehem Steel personnel to compare actual emission rates with applicable standards set forth in PADER Regulations, Chapter 123.13.



APPENDIX 1
FIELD SAMPLING PROGRAM



APPENDIX 1

FIELD SAMPLING PROGRAM

1.0 SAMPLING PROCEDURES

1.1 Test Station and Traverse Locations - Particulate Testing

The locations of the sampling stations and traverse points are critical to the performance of the project. An explanation of the sampling points used during the project follows.

The internal diameter of the "A" Battery Push Emission Scrubber exhaust stack was 96 inches. Four test ports were located 90 degrees apart for optimum sampling. Sixteen traverse points were selected (4 per port) to account for each of the 16 coke oven pushes.

1.2 Gas Flow and Gas Temperature Determinations

The gas flow rate and temperature profile were measured at each location by conducting a simultaneous velocity and temperature traverse. Gas velocity heads were measured with a calibrated "S"-type pitot tube, which was connected to an inclined manometer. A Chromel-Alumel thermocouple connected to a potentiometer was used to determine the gas temperature.

1.3 Cyclonic Flow Determinations

A check for the presence of cyclonic flow in the outlet stack was performed using an "S"-type pitot, an inclined portable manometer, and a precision protractor. The direction parallel to the duct walls was assigned a reference value of zero, and the deviation of the stack gas flow (in \pm degrees from zero) was recorded for each traverse point. The absolute values of these angles were then averaged and compared to the maximum allowable deviation (10 degrees).

1.4 Moisture Content

Sampling was conducted employing the principles presented in EPA Method 4, and concurrently with particulate sampling. The parameters evaluated to determine the gas stream's moisture content were: sample gas volume, sample gas temperature, sample gas pressure, impinger moisture gain, and silica gel moisture gain. Some minor modifications were made to the Method 4 train to allow for the concurrent sampling of particulate and moisture content. These modifications did not deviate from sampling principles.

Modifications, such as the substitution of a glass fiber filter for Pyrex wool as a filtering medium and the substitution of a calibrated orifice for a rotameter as a flow metering device, were incorporated.

1.5 Particulate Sampling

The sampling procedures and equipment employed were those outlined in Method 5 of the Federal Register, Volume 42, Number 160, August 18, 1977. This methodology also complied with PADER testing regulations.

The size of the nozzle required to maintain isokinetic sampling was calculated from the results of the previously completed velocity and temperature traverses. The sampling train used a stainless steel probe, heated to 250°F by an internal heating element. A nozzle of the calculated size was attached to the end of the probe, which was inserted into the stack. A calibrated "S"-type pitot tube and a Chromel-Alumel thermocouple were clamped to the probe, and used to monitor the velocity head and temperature at the traverse points during the sampling period. Sampled gas passed through the nozzle and the probe to the glass fiber filter for removal of suspended particulates. The filter was housed in a heated chamber where the temperature was maintained at 248°F ±25 degrees. From the filter, the stack gas passed to the impinger train. The first two impingers each contained 150 ml of deionized water. The third impinger contained no reagents and was a knockout impinger. The fourth impinger contained approximately 200 grams of coarse silica gel, which collected any moisture and/or vapors that had not been captured in the preceding impingers.

The second impinger was a 500-ml Greenburg-Smith impinger, while the first, third, and fourth impingers were 500-ml units of the Greenburg-Smith design, modified by replacing the tip with a 1/2-inch ID glass tube. The impinger train was immersed in an ice bath for the entire test period so that the exit gas temperature would not exceed 68°F.

From the impinger train, the gas was conducted through an umbilical cord to the control console (a Model 2343 RAC Stack Sampler), which contained the following pieces of equipment (listed in the order in which sampled gas passed through them): a main valve, a bypass valve for flow adjustment, an airtight vacuum pump, a dry gas meter, and a calibrated orifice. The orifice was equipped with pressure taps that were connected across the inclined manometer and used to ensure that isokinetic conditions were being maintained. A schematic diagram of the sampling train appears at the end of this appendix.

The sampling train was checked for leaks before and after each sample run. The inlet of the nozzle was plugged and the pump vacuum was held at the highest vacuum attained during that period of testing. In all cases, the leakage rate was minimal and did not exceed the maximum allowable leakage rate of 0.02 cfm.



Upon completion of a test, the soiled glass fiber filter was removed from its filter holder and placed in a Petri dish, which was subsequently sealed. The probe and nozzle were washed internally, first with distilled water, and then with acetone. The particulate matter remaining in the probe was removed with a nylon brush attached to a polyethylene line. The front half of the glass filter holder was also rinsed with distilled water and acetone. The washings obtained were added to the washings collected from the nozzle and probe. All distilled water and acetone washings were stored in separate sealed polyethylene sample bottles for transfer to the laboratory. The silica gel used in the fourth impinger was removed and stored in a sealed sample bottle. The contents of the first, second, and third impingers were combined, measured volumetrically, and stored in a sealed sample bottle. A distilled water wash of the impingers was added to this same bottle. A final acetone rinse of impingers was conducted, and the washings were stored in a separate sealed sample bottle.

Blanks of the distilled water and acetone were taken to be analyzed for residue at BCM's laboratory.

1.6 Molecular Weight Determinations

A Fyrite gas analyzer was used to determine the molecular weight of the exhaust gas. The following parameters were measured in order to calculate molecular weight: volume percent carbon dioxide (CO₂), and volume percent oxygen (O₂). Volume percent nitrogen (N₂) was determined by difference.

2.0 FIELD DATA SHEETS

The flue gas velocity head, flue gas temperature, inlet and outlet dry gas meter temperatures, orifice pressure differential, sample volume, sampling time, pump vacuum, filter temperature, and the impinger train outlet gas temperature were recorded during the sampling program. The field data sheets generated during the program follow.



NOMOGRAPH DATA

PLANT Bethlehem Steel

DATE 8-27-87

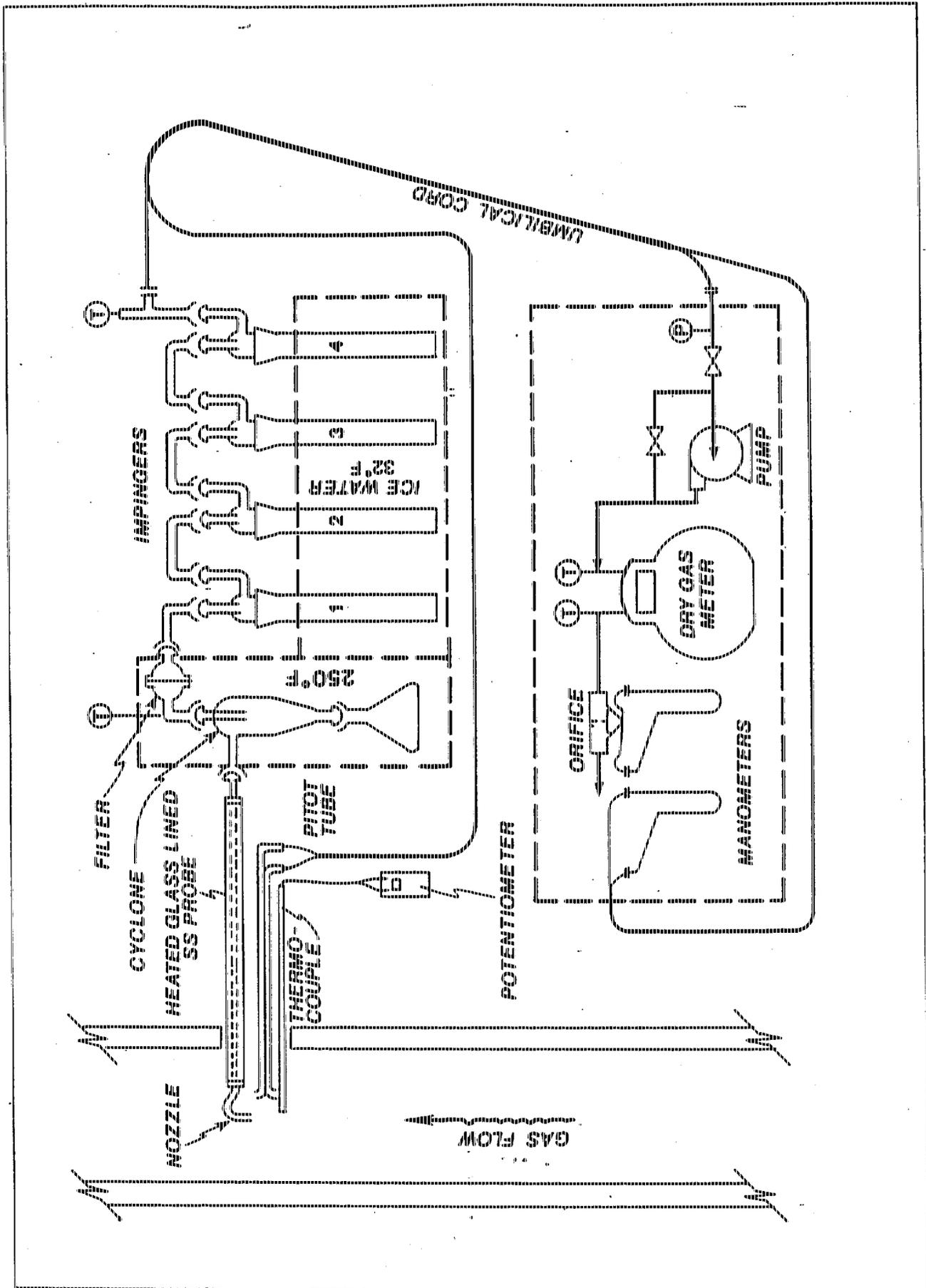
SAMPLING LOCATION "A" push emission scrubber

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H ₂ O	ΔH_0	1.70
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m,avg.}$	95°
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{vo}	3
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073 \times$ STACK GAUGE PRESSURE in in. H ₂ O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s,avg.}$	116°
AVERAGE VELOCITY HEAD, in. H ₂ O	$\Delta P_{avg.}$.52
MAXIMUM VELOCITY HEAD, in. H ₂ O	$\Delta P_{max.}$.78
C FACTOR		1.0
CALCULATED NOZZLE DIAMETER, in.		.245
ACTUAL NOZZLE DIAMETER, in.		.20
REFERENCE Δp , in. H ₂ O		1.2

$C_p = .84$

PLANT	TRaverse Point Number	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V ₁ /V ₂)	VELOCITY HEAD (ft ² in. H ₂ O)	ORIFICE PRESSURE DIFFERENTIAL (in. H ₂ O)		STACK TEMPERATURE (°F)	DRY GAS METER TEMPERATURE (°F)		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	HUMIDIFIER TEMPERATURE, °F
						DESIRED	ACTUAL		INLET (°F)	OUTLET (°F)			
SW			12:44	310.3					64	64	5	250	54
H		1:25	16:04	311.3	1.0	1.55	1.55	101	64	64	5	250	54
3		1:25	17:12	312.3	1.0	1.55	1.55	104	64	64	5	255	54
3		1:25	17:24	312.4	1.0	1.4	1.4	104	64	64	5	245	52
1		1:25	17:38	315.1	.9	1.3	1.3	106	64	64	5	255	56
H		1:25	17:50	316.1	.9	1.4	1.4	103	64	64	5	255	56
3		1:30	18:01	317.1	.88	1.35	1.35	126	64	64	5	255	56
3		1:30	18:34	318.1	.61	1.3	1.3	126	64	64	5	245	54
1				317.183	.7								

Lead Acid note: .018



EPA METHOD 5



APPENDIX 2
LABORATORY ANALYSIS AND DATA REDUCTION

APPENDIX 2

LABORATORY ANALYSIS AND DATA REDUCTION

1.0 ANALYTICAL METHODS

All samples generated during the test program were analyzed at BCM's laboratory in Norristown, Pennsylvania. The following discussions describe the analytical methods employed.

1.1 Particulate Samples - Push Emission Scrubber

Prior to their use in the field, all glass fiber filters used in the sampling program were tare-weighted following a 24-hour desiccation period. Upon their return to the laboratory, they were desiccated and reweighed. The weight difference was the amount of sample collected.

Nozzle, probe, and filter holder distilled water washings and acetone washings were evaporated to dryness in separate tared beakers. The residue was desiccated and the beakers were reweighed to a constant weight. The weight difference was the amount of particulate matter collected at those locations in the sampling train. Impinger solutions were filtered through a 0.22-micron filter to determine the insoluble back-half particulate.

The filtrate and acetone wash of the impingers were dried separately to determine the soluble back-half particulate.

Acetone and distilled water blanks were evaporated to dryness in tared beakers, and were desiccated and reweighed. Any residue that remained was a contaminant in the reagent and was considered a blank weight used as a correction factor in subsequent calculations. The laboratory results of the particulate sampling program are listed in Tables 2-1 and 2-2.

2.0 COMPUTER INPUT SHEET

The reduced data calculated from the field data sheets were combined with the laboratory results on the computer input data sheet to facilitate programming. The computer input data sheet follows page 2-3.

3.0 CALCULATIONS

The equations used to calculate the results of the particulate test program follow the computer input data sheet.



TABLE 2-1

PARTICULATE LABORATORY RESULTS
FRONT-HALF PARTICULATE CATCH (mg)

Run Number	Filter	P&C Water Wash*	P&C Acetone Wash*	Total Catch
1	13.9	22.5	9.7	46.1

* Blank-corrected results



TABLE 2-2

PARTICULATE LABORATORY RESULTS
BACK HALF PARTICULATE CATCH (mg)

Run Number	Insoluble Back Half	Impingers and Water Wash*	Impinger Acetone Wash*	Total Catch
1	1.2	5.9	1.8	8.9

* Blank-corrected results



4.0 TEST RESULTS

The complete results of the computer analysis, and data reduction of the input generated from the particulate sampling program, follow the equations for particulate, moisture, and flow calculations.

PORTLAND CEMENT STEEL	
1	1
2	1
3	1
4	1
5	0.239
6	115
7	2.377
8	64
9	1.41
10	.26
11	2.22
12	0
13	0
14	21
15	2.27
16	27.07
17	2.24
18	.76
19	1.0
20	49.3
21	0
22	0
23	0
24	0
25	1.0
26	1.0
27	0
28	0
29	0

- 1 Heading
- 2 Number of tests
- 3 Test type (CFM, PPA, PF, or H2S)
- 4 Test identification (ID's in quotes)
- 5 Stack area, in²
- 6 Stack temperature, °F
- 7 Sample volume, ft³
- 8 Meter temperature, °F
- 9 Orifice (ΔH), in. H₂O
- 10 Nozzle diameter, in
- 11 Duration of test, min.
- 12 Volume of CO₂, %
- 13 Volume of CO, %
- 14 Volume of O₂, %
- 15 Static pressure, in. H₂O
- 16 Barometric pressure, in. Hg
- 17 Pitot correction factor
- 18 Traverse (Avg√ΔP), in. H₂O
- 19 Volume H₂O collected, ml
- 20 Weight collected, mg
- 21 Volume titrant, SO₂, ml
- 22 Volume titrant, SO₂, ml
- 23 Normality titrant, SO₂
- 24 Normality titrant, SO₂
- 25 Meter calibration factor
- 26 Avg. cosine of angle
- 27 Pass leak check rate, CFM
- 28 Leak check rate no. 1, CFM
- 29 Leak check time no. 1, min.

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 File No. 257A, 4A

EQUATIONS FOR PARTICULATE, MOISTURE, AND FLOW CALCULATIONS
 (BASED ON STANDARD CONDITIONS OF 68°F AND 29.92"Hg)

1. $V_{w(\text{std})} = 0.0471 V_{wc}$
2. $V_{m(\text{std})} = 17.64 V_m \frac{P_{\text{bar}} + .07355 \Delta H}{T_m + 460}$
3. $B_{wo} = \frac{V_{w(\text{std})}}{V_{m(\text{std})} + V_{w(\text{std})}}$
4. $M_d = 0.44(\%CO_2) + 0.28(\%CO) + 0.32(\%O_2) + 0.28(\%N_2)$
5. $M_s = M_d (1 - B_{wo}) + 18 B_{wo}$
6. $EA = \frac{(\%O_2) - 0.5(\%CO)}{0.264(\%N_2) - (\%O_2) + 0.5(\%CO)} 100$
7. $V_s = (85.49)(60)(C_p) \sqrt{\frac{P_s}{P}} \sqrt{\frac{T_s + 460}{(P_s)(M_s)}}$
8. $Q_s = \frac{(V_s)(A_s)}{144}$
9. $Q_{s(\text{std})} = Q_s (1 - B_{wo}) 17.64 \frac{P_s}{T_s + 460}$
10. $C'_s = 0.0154 \frac{W_t}{V_{m(\text{std})}}$
11. $C'_w = 0.0154 \frac{W_t}{V_{m(\text{std})} + V_{w(\text{std})}}$
12. $C'_c = \frac{12 C'_s}{\%CO_2}$
13. $C'_a = W_w \frac{(T_s + 460)(29.92)}{(528)(P_s)}$
14. $E = 0.00857 Q_{s(\text{std})} C'_s$
15. $A_n = \frac{(\pi)(D_n)^2}{(144)(4)}$
16. $I = \frac{(60)(1.667)(T_s + 460)(0.00267 V_{wc} + V_{m(\text{std})}/17.64)}{(\theta)(V_s)(P_s)(A_n)}$

LEGEND

A_n	=	Area of nozzle, ft^2
A_s	=	Area of stack, in^2
B_{wo}	=	Moisture content of gas stream, dimensionless
C_p	=	Pitot correction factor, dimensionless
C'_a	=	Particulate concentration (stack conditions), gr/ft^3
C'_c	=	Particulate concentration at 12% CO_2 (dry), $gr/dscf$
C'_s	=	Particulate concentration (dry), $gr/dscf$
C'_w	=	Particulate concentration (wet), gr/scf
D_n	=	Diameter of nozzle, in.
E	=	Particulate emission rate, lb/hr
EA	=	Excess air, percent
ΔH	=	Orifice pressure drop, in. H_2O
I	=	Isokinetic ratio, percent
M_d	=	Dry molecular weight of stack gas, lb/lb-mole
M_s	=	Molecular weight of stack gas, lb/lb-mole
P_{bar}	=	Barometric pressure, in. Hg
P_s	=	Stack pressure (absolute), in. Hg
$\sqrt{\Delta P}$	=	Average of square roots of pitot pressure differential, in. H_2O
Q_s	=	Stack gas flow, acfm
$Q_s(\text{std})$	=	Stack gas flow, scfm
T_m	=	Average dry gas meter temperature, $^{\circ}F$
T_s	=	Average stack temperature, $^{\circ}F$
V_m	=	Dry sample volume (meter conditions), ft^3
$V_m(\text{std})$	=	Dry sample volume (standard conditions), ft^3

V_s = Stack velocity, ft/min

V_{wc} = Volume of liquid collected in impingers and silica gel, ml

$V_{w(std)}$ = Volume of liquid collected, ft³

W_t = Total weight of particulates collected, mg

θ = Duration of test, min.

BETHLEHEM STEEL

PARAMETERS:

AREA OF BLEEDING (SQ FT) 50.86
SAMPLE VOLUME (DSCF) 16.392
MOISTURE (%) 2.8
MOLECULAR WEIGHT (LB/LB-MOLE) 28.54
GAS TEMPERATURE (F) 118.0
GAS VELOCITY (FT/MIN) 3415.7
GAS VOLUME (DRY SCFH) 151284.1
GAS VOLUME (ACFM) 171688.8

PARTICULATE EMISSIONS:
CONCENTRATION (GRAINS/DSCF) .0445
CONC. @ STK COND. (GRAINS/CF) .0392
EMISSION RATE (LB/HR) 57.7608

ORSAT ANALYSIS:
CARBON DIOXIDE (VOL %) 0
CARBON MONOXIDE (VOL %) 0
OXYGEN (VOL %) 21.0
NITROGEN (VOL %) 79.0

EXCESS AIR (%) -1453.2
TURBINE TIC (%) 107.3



APPENDIX 3
EQUIPMENT CALIBRATION

1.0 PITOT CALIBRATION

The pitot tubes were calibrated by measuring the velocity head in a duct with both an "S" type pitot and a standard pitot with a known coefficient. This was done at several different velocities. The pitot tube coefficient can be calculated as follows:

$$C_{p(\text{test})} = C_{p(\text{std})} \sqrt{\frac{\Delta^P_{\text{std}}}{\Delta^P_{\text{test}}}}$$

Where:

$C_{p(\text{test})}$ = Pitot tube coefficient of "S" type pitot

$C_{p(\text{std})}$ = Pitot tube coefficient of standard pitot

Δ^P_{test} = Velocity head measured by "S" type pitot

Δ^P_{std} = Velocity head measured by standard pitot

Coefficients were determined for each leg of the "S" type pitot. No C_p may deviate more than ± 0.01 from the average C_p , and the difference between the average C_p for each leg must be ≤ 0.01 .

2.0 DRY GAS METER AND ORIFICE METER

The dry gas meter and orific were calibrated using a wet test meter. Gases were moved through the dry gas meter at orifice pressure differentials (ΔH 's) of 0.5, 1.0, and 2.0 inches of water. With the information obtained, γ , the ratio of accuracy of wet test meter to dry test meter; and ΔH_o , the orifice pressure

differential that gives 0.75 cfm of air at 68°F and 29.92 inches of mercury, were calculated. The γ has a tolerance of 1.00 \pm 0.01 and the ΔH_{θ} has a tolerance of 1.84 +0.26 -0.24. The γ and ΔH_{θ} are determined as follows:

$$\gamma = \frac{V_w P_b (t_d + 460)}{V_d [P_b + 0.07353 (\Delta H)] (t_w + 460)}$$

$$\Delta H_{\theta} = \frac{0.0317 (\Delta H)}{P_b (t_d + 460)} \left(\frac{(t_w + 460) \theta}{V_w} \right)^2$$

Where:

- ΔH = Orifice pressure differential, in H₂O
- P_b = Barometric pressure, in Hg
- t_d = Average temperature of dry gas meter, °F
- t_w = Average temperature of wet test meter, °F
- θ = Duration of test, min.
- V_d = Dry gas meter volume, ft³
- V_w = Wet test meter volume, ft³

3.0 POTENTIOMETER CALIBRATION

The Thermo - Electron potentiometers were calibrated by using a known voltage source as an input to the potentiometer.

4.0 PROBE CALIBRATION

The probes were calibrated by measuring the outlet temperatures at various variable transformer settings while passing air through at approximately 0.75 cubic feet per minute.



APPENDIX 4
PERTINENT REGULATIONS

requirements of § 129.15(c) of this Title (relating to coke pushing operation) have been satisfied. Upon such demonstration, the Department will issue a determination, in writing, either as an operating permit condition, for those sources subject to permit requirements under the act, or as an order containing appropriate conditions and limitations.

(c) Any person responsible for any source specified in items (1) through (7) or (9) of subsection (a) of this section shall take all reasonable actions to prevent particulate matter from becoming airborne. Such actions shall include, but not be limited to, the following:

(1) Use, where possible, of water or chemicals for control of dust in the demolition of buildings or structures, construction operations, the grading of roads, or the clearing of land.

(2) Application of asphalt, oil, water or suitable chemicals on dirt roads, material stockpiles, and other surfaces which may give rise to airborne dusts.

(3) Paving and maintenance of roadways.

(4) Prompt removal of earth or other material from paved streets onto which earth or other material has been transported by trucking or earth moving equipment, erosion by water, or other means.

(d) The requirements contained in subsection (a) of this section and § 123.2 of this Title (relating to fugitive particulate matter) shall not apply to fugitive emissions arising from the production of agricultural commodities in their unmanufactured state on the premises of the farm operation.

§123.2. Fugitive particulate matter.

No person shall cause, suffer, or permit fugitive particulate matter to be emitted into the outdoor atmosphere from any source or sources specified in items (1) through (9) of §123.1(a) of this Title (relating to prohibition of certain emissions) if such emissions are:

(1) either visible, at any time, at the point such emissions pass outside the person's property, irrespective of the concentration of particulate matter in such emissions; or

(2) not visible at the point such emissions pass outside the person's property and the average concentration, above background, of three samples, of such emissions at any point outside the person's property, exceeds 150 particles per cubic centimeter.

PARTICULATE MATTER EMISSIONS

§123.11. Combustion units.

(a) No person shall cause, suffer, or permit the emission into the outdoor atmosphere of particulate matter, at any time, from any combustion unit in excess of:

(1) The rate of 0.4 lbs. per million B.t.u. of heat input, when the heat input to the combustion unit in millions of B.t.u.'s per hour is greater than 2.5 but less than 50.

(2) The rate determined by the formula:

$$A = 3.6E^{-0.16}$$

where:

A = Allowable emissions in pounds per million B.t.u. of heat input, and

E = Heat input to the combustion unit in millions of B.t.u.'s per hour.

when E is equal to or greater than 50 but less than 500.

(3) The rate of 0.1 pounds per million B.t.u. of heat input when the heat input to the combustion unit in millions of B.t.u.'s per hour is equal to or greater than 500.

(b) Allowable emissions under subsection (a) of this section are graphically indicated in Appendix A to this Chapter.

§123.12. Incinerators.

No person shall cause, suffer, or permit the emission to the outdoor atmosphere of particulate matter from any incinerator, at any time, in such a manner that the particulate matter concentration in the effluent gas exceeds 0.1 grain per dry standard cubic foot, corrected to 12% carbon dioxide.

§123.13. Processes.

(a) The provisions of subsections (b) and (c) of this section shall apply to all processes except combustion units and incinerators.

(b) No person shall cause, suffer, or permit the emission into the outdoor atmosphere of particulate matter from any process listed in the following table, at any time, either in excess of the rate calculated by the formula set forth in paragraph (2) of this subsection or in such a manner that the concentration of particulate matter in the effluent gas exceeds 0.02 grains per dry standard cubic foot, whichever is greater:

Table

TABLE 1

Process	Process Factor, F
1. Carbon black mfg.	500 lbs./ton of product
2. Charcoal mfg.	400 lbs./ton of product
3. Crushers or grinders or screens	20 lbs./ton of feed
4. Paint mfg.	0.05 lbs./ton of pigment handled
5. Phosphoric acid mfg.	6 lbs./ton of phosphorous burned
6. Detergent drying	30 lbs./ton of product
7. Alfalfa dehydration	30 lbs./ton of product
8. Grain elevators.	
Loading or unloading	90 lbs./ton of grain
9. Grain screening and cleaning	300 lbs./ton of grain
10. Grain drying	200 lbs./ton of product
11. Meat smoking	0.01 lbs./ton of meat
12. Ammonium nitrate mfg.	
Granulator	0.1 lbs./ton of product
13. Ferroalloy production furnace	0.3 lbs./ton of product
14. Primary iron and/or steel making:	
Iron production	100 lbs./ton of product
Sintering: windbox	20 lbs./ton of dry solids feed
Steel production	40 lbs./ton of product
Scarfing	20 lbs./ton of product
15. Primary lead production:	
Roasting	0.004 lbs./ton of ore feed
Sintering: windbox	0.2 lbs./ton of sinter
Lead reduction	0.5 lbs./ton of product

16. Primary zinc production:	
Roasting	3 lbs./ton of ore feed
Sintering: windbox	2 lbs./ton of product
Zinc reduction	10 lbs./ton of product
7. Secondary aluminum production:	
Sweating	50 lbs./ton of aluminum product
Melting and refining	10 lbs./ton of aluminum feed
15. Brass and bronze production	
Melting and refining	20 lbs./ton of product
19. Iron foundry:	
Melting:	
5T./hr. and less	1.50 lbs./ton of iron
More than 5T./hr.	50 lbs./ton of iron
Sand handling	20 lbs./ton of sand
Shake-out	20 lbs./ton of sand
20. Secondary lead smelting	0.5 lbs./ton of product
21. Secondary magnesium smelting	0.2 lbs./ton of product
22. Secondary zinc smelting:	
Sweating	0.01 lbs./ton of product
Refining	0.3 lbs./ton of product
23. Asphaltic concrete production	6 lbs./ton of aggregate feed
24. Asphalt roofing mfg:	
Felt saturation	0.6 lbs./ton of asphalt used
25. Portland cement mfg:	
Clinker production	150 lbs./ton of dry solids feed
Clinker cooling	30 lbs./ton of product
26. Coal dry-cleaning	2 lbs./ton of product
17. Lime calcining	200 lbs./ton of product
18. Petroleum refining:	
Catalytic cracking	40 lbs./ton of liquid feed
19. Pressed, blown and spun glass, glass production melting furnaces:	50 lbs./ton of fuel
(10) By product coke production: pushing operation:	1 (lb./ton coke pushed)
(2) Formula	0.42
A = 0.76E	where:
A = Allowable emissions in lbs./hr	
E = Emission index = F x W lbs./hr.	
F = Process factor in lbs./unit, and	
W = Production or charging rate in units/hr.	

The factor F shall be obtained from the table in paragraph (1) of this subsection. The units for F and W shall be compatible.

(3) *Allowable emissions.* Allowable emissions under this subsection are graphically indicated in Appendix B to this chapter.

(c) For processes not listed in subsection (b)(1) of this section including but not limited to coke oven battery waste heat stacks and autogeneous zinc coker waste heat stacks, the following shall apply:

(1) *Prohibited emissions.* No person shall cause, suffer, or permit the emission into the outdoor atmosphere of particulate matter from any process not listed in subsection (b)(1) of this section in such a manner that the concentration of particulate matter in the effluent gas, at any time, exceeds any of the following:

(i) 0.04 grains per dry standard cubic foot, when the effluent gas volume is less than 150,000 dry standard cubic feet per minute.

(ii) The rate determined by the formula:

A = 6000E⁻¹, where:

A = Allowable emissions in grains per dry standard cubic foot, and

E = Effluent gas volume in dry standard cubic feet per minute.

when E is equal to or greater than 150,000 but less than 300,000.

(iii) 0.02 grains per dry standard cubic foot, when the effluent gas volume is greater than 300,000 dry standard cubic feet per minute.

(2) *Allowable emissions.* Allowable emissions under this subsection are graphically indicated in Appendix C to this Chapter.

SULFUR COMPOUND EMISSIONS

§123.21. General.

(a) This section shall apply to all sources except those subject to other provisions of this Article, with respect to the control of sulfur compound emissions.

(b) No person shall cause, suffer, or permit the emission into the outdoor atmosphere of sulfur oxides, from any source, in such a manner that the concentration, at any time, of the sulfur oxides, expressed as SO₂, in the effluent gas exceeds 500 parts per million, by volume (dry basis).

§123.22. Combustion units.

(a) *Non-air basin areas.*

(1) *General provision.* No person shall cause, suffer, or permit the emission into the outdoor atmosphere of sulfur oxides, expressed as SO₂, from any combustion unit, at any time, in excess of the rate of four pounds per million B.T.U. of heat input over any one-hour period except as provided for in paragraph (4) of this subsection.

(2) *Commercial fuel oil.* No person shall, at any time, offer for sale, deliver for use, exchange in trade, cause the use of, suffer the use of, or permit the use of commercial fuel oil in non-air basin areas which contains sulfur in excess of the applicable percentage by weight set forth in the following table:

Grades Commercial Fuel Oil	% Sulfur
No. 2 and Lighter (viscosity less than or equal to 5.320cSt)	0.5
No. 4, No. 5, No. 6, and heavier (viscosity greater than 5.320cSt)	2.3

(3) *Equivalency provision.* Paragraph (2) of this subsection shall not apply to those persons or installations where equipment or processes are used to reduce the emissions from the burning of fuels with a higher sulfur content than that specified in paragraph (2) of this subsection. Such emissions shall not exceed those which would result from the use of the fuels specified in paragraph (2) of this subsection.